B27

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 601 072 B1

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
28.05.1997 Bulletin 1997/22

(21) Application number: **92919073.4**

(22) Date of filing: **17.08.1992**

(51) Int Cl.[6]: **G02F 1/167**, G09G 3/34

(86) International application number:
PCT/US92/06877

(87) International publication number:
WO 93/04459 (04.03.1993 Gazette 1993/06)

(54) ELECTROPHORETIC DISPLAY PANEL WITH INTERLEAVED LOCAL ANODE

ELEKTROPHORETISCHE ANZEIGEVORRICHTUNG MIT VERSCHACHTELTER LOKALER ANODE

PANNEAU D'AFFICHAGE PAR ELECTROPHORESE A ANODE LOCALE IMBRIQUEE

(84) Designated Contracting States:
BE DE FR GB NL

(30) Priority: **19.08.1991 US 746854**

(43) Date of publication of application:
15.06.1994 Bulletin 1994/24

(73) Proprietor: **COPYTELE INC.**
Huntington Station New York 11746 (US)

(72) Inventors:
- **DISANTO, Frank, J.**
  North Hills, NY 11030 (US)
- **KRUSOS, Denis, A.**
  Lloyd Harbor, NY 11743 (US)
- **SCHUBERT, Frederic, E.**
  Shoreham, NY 11786 (US)

(74) Representative: **Lucking, David John**
FORRESTER & BOEHMERT
Franz-Joseph-Strasse 38
80801 München (DE)

(56) References cited:
US-A- 4 686 524
US-A- 4 742 345
US-A- 5 053 763
US-A- 5 077 157

EP 0 601 072 B1

Printed by Jouve, 75001 PARIS (FR)

Description

Technical Field of the Invention

The present invention relates to an electrophoretic display panel apparatus and methods for making same and, more particularly, to electrophoretic display panels with a local anode having elements which are interleaved with the grid elements of the display for assisting in the control of pigment particle migration and position.

Background Art

Electrophoretic displays (EPIDS) are now well known. A variety of display types and features are taught in several patents issued in the names of the inventors herein, Frank J. DiSanto and Denis A. Krusos and assigned to the assignee herein, Copytele, Inc. of Huntington Station, New York. For example, U.S Patent Nos. 4,655,897 and 4,732,830, each entitled ELECTROPHORETIC DISPLAY PANELS AND ASSOCIATED METHODS describe the basic operation and construction of an electrophoretic display. U.S. Patent No. 4,742,345, entitled ELECTROPHORETIC DISPLAY PANELS AND METHODS THEREFOR, describes a display having improved alignment and contrast. Many other patents regarding such displays are also assigned to Copytele, Inc. One pending patent application which may have some relevance to the present invention is EP-A-0 396 247 (Application No. 07/345,825) entitled DUAL ANODE FLAT PANEL ELECTROPHORETIC DISPLAY APPARATUS, each of which shall be described below.

The display panels shown in the above-mentioned patents operate upon the same basic principle, viz., if a suspension of electrically charged pigment particles in a dielectric fluid is subjected to an applied electrostatic field, the pigment particles will migrate through the fluid in response to the electrostatic field. Given a substantially homogeneous suspension of particles having a pigment color different from that of the dielectric fluid, if the applied electrostatic field is localized it will cause a visually observable localized pigment particle migration. The localized pigment particle migration results either in a localized area of concentration or rarefaction of particles depending upon the sign and direction of the electrostatic field and the charge on the pigment particles. The electrophoretic display apparatus taught in the foregoing U.S. Patents are "triode-type" displays having a plurality of independent, parallel, cathode row conductor elements or "lines" deposited in the horizontal on one surface of a glass viewing screen. A layer of insulating photoresist material deposited over the cathode elements and photoetched down to the cathode elements to yield a plurality of insulator strips positioned at right angles to the cathode elements, forms the substrate for a plurality of independent, parallel column or grid conductor elements or "lines" running in the vertical direction. A glass cap member forms a fluid-tight seal with the viewing window along the cap's peripheral edge for containing the fluid suspension and also acts as a substrate for an anode plate deposited on the interior flat surface of the cap. When the cap is in place, the anode surface is in spaced parallel relation to both the cathode elements and the grid elements. Given a specific particulate suspension, the sign of the electrostatic charge which will attract and repel the pigment particles will be known. The cathode element voltage, the anode voltage, and the grid element voltage can then be ascertained such that when a particular voltage is applied to the cathode and another voltage is applied to the grid, the area proximate their intersection will assume a net charge sufficient to attract or repel pigment particles in suspension in the dielectric fluid. Since numerous cathode and grid lines are employed, there are numerous discrete intersection points which can be controlled by varying the voltage on the cathode and grid elements to cause localized visible regions of pigment concentration and rarefaction. Essentially then, the operating voltages on both cathode and grid must be able to assume at least two states corresponding to a logical one and a logical zero. Logical one for the cathode may either correspond to attraction or repulsion of pigment. Typically, the cathode and grid voltages are selected such that only when both are a logical one at a particular intersection point, will a sufficient electrostatic field be present at the intersection relative to the anode to cause the writing of a visual bit of information on the display through migration of pigment particles. The bit may be erased, e.g., upon a reversal of polarity and a logical zero-zero state occurring at the intersection coordinated with an erase voltage gradient between anode and cathode. In this manner, digitized data can be displayed on the electrophoretic display.

An alternative EPID construction is described in Application No. 07/345,825, referred to above, which relates to an electrophoretic display in which the cathode/grid matrix as is found in triode-type displays is overlayed by a plurality of independent separately addressable "local" anode lines. The local anode lines are deposited upon and align with the grid lines and are insulated therefrom by interstitial lines of photoresist. The local anode lines are in addition to the "remote" anode, which is the layer deposited upon the anode faceplate or cap as in triode displays. The dual anode structure aforesaid provides enhanced operation by eliminating unwanted variations in display brightness between frames, increasing the speed of the display and decreasing the anode voltage required during Write and Hold cycles, all as explained in Application No. 07/345,825.

An examination of Application No. 07/345,825 reveals that the local anode structure employed therein is realized by applying a layer of photoresist over the grid elements, which are formed from a first metal, such as, chrome. A layer of a second metal, e.g., nickel or alu-

minum, is applied over the photoresist layer. Yet another layer of photoresist is applied over the second metal layer, and is then masked, exposed and developed in the same form as the grid elements. The second metal layer is then etched with a suitable solution. The photoresist between the first and second metal layers is then plasma etched. A layer of SiO_2 is then deposited over the resulting structure.

It is an object of the present invention to provide an alternative structure and method for making the remote anode/cathode/grid matrix than that shown in Application No. 07/345,825.

Disclosure of the Invention

The problems and disadvantages associated with conventional electrophoretic displays are overcome by the present invention which consists of an electrophoretic display as defined in claims 1 and 10 and a method for fabricating an electrode matrix for such displays as defined in claim 17. The inventive electrophoretic displays have : a cathode matrix comprising a plurality of parallel lines arranged in a given direction, a grid matrix insulated from the cathode matrix and comprising a plurality of parallel lines each perpendicular to the cathode lines to form an X-Y addressing matrix, and a conventional anode electrode separated from the X-Y matrix, the space between the anode electrode and the X-Y matrix accommodating an electrophoretic dispersion including pigment particles suspended in a fluid; the improvement therewith of an additional anode electrode comprising a plurality of parallel lines each associated with and insulated from the grid lines. The additional anode electrode is disposed within a plane shared by the grid matrix and operates to control the path of the pigment particles to and from the X-Y matrix and to allow excess pigment to remain at the conventional anode electrode.

Further embodiments of the invention are defined in the dependent claims.

Brief Description of the Drawings

For a better understanding of the present invention, reference is made to the following detailed description of an exemplary embodiment considered in conjunction with the accompanying drawings, in which:

FIG. 1 is an exploded perspective view of an electrophoretic display in accordance with an exemplary embodiment of the present invention.

FIG. 2 is an enlarged plan view of a selected local anode element interleaved with a selected grid element in accordance with an exemplary embodiment of the present invention and as shown in FIG. 1.

FIG.3 is a cross-sectional view of the electrophoretic display shown in FIG. 1 in the unexploded state, taken along section line III-III and looking in the direction of the arrows.

FIG. 4 is an enlarged plan view of a selected grid and/or local anode element structure as is taught in prior Application No. 07/345,825 filed by the inventors herein.

FIG.5 is a cross-sectional fragmentary view of an electrophoretic display in accordance with Application No. 07/345,825 and which incorporates the element structure shown in FIG. 4.

Best Mode for Carrying Out the Invention

FIG. 1 shows an electrophoretic display 10 in accordance with the present invention. The display 10 has an anode faceplate 12 and a cathode faceplate 14 which are sealably affixed on either side of an interstitial spacer 16 to form a fluid-tight envelope for containing a dielectric/pigment particle suspension or electrophoretic fluid (not shown). The faceplates 12 and 14 are typically flat glass plates upon which are deposited conductor elements to comprise the situs of electrostatic charge for inducing motion in the electrophoretic fluid. The techniques, materials and dimensions used to form the conductor elements upon the faceplates and the methods for making EPIDS, in general, are shown in U.S. Patent Nos. 4,655,897, 4,732,830 and 4,742,345.

In the invention, as depicted in FIG. 1, for example, a plurality of independent, electrically conductive cathode lines 18, shown here as horizontal rows, are deposited upon the cathode faceplate 14 using conventional deposition and etching techniques. Of course, the orientation of the cathode lines depends upon the orientation of the screen, which, if rotated 90 degrees, would position the cathode lines vertically, thus, the cathode lines are arbitrarily defined as horizontal. It is preferred that the cathode elements 18 be composed of Indium Tin Oxide (ITO) as set forth in U.S. Patent No. 4,742,345. A plurality of independent grid conductor lines 20 are superposed in the vertical over the cathode elements 18, i.e., at right angles thereto, and are insulated therefrom by an interstitial photoresist layer 22 (see FIG. 2). The grid elements 20 may be formed by coating the photoresist layer 22 with a metal, such as nickel, using sputtering techniques or the like, and then selectively masking and etching to yield the intersecting but insulated configuration shown in FIG. 1. Each cathode and grid element 18, 20 terminates at one end in a contact pad 24c and 24g, respectively, or is otherwise adapted to permit connection to display driver circuitry (not shown). An anode 26 is formed on an interior surface of the anode faceplate 12 by plating with a thin layer of conductor material, such as, chrome.

Whereas the foregoing components have been previously described in prior patents and applications of the present Applicants, the present invention includes a novel local anode 28 structure. As stated above, the benefits and operation of an EPID having a local anode have been recognized and described in Application No. 07/345,825 by the present Applicants. Previously, however, the local anode lines have been formed super-

posed over and in alignment with the grid elements, and separated therefrom by an interstitial layer of photoresist insulation (see FIG. 5). In the present invention, the local anode 28 lines are formed at the same time, of the same material and in the same plane as the grid elements 20. This is accomplished by interleaving the local anode 28 and grid 20 elements. Thus, the mask that was used to form the plurality of grid lines has been altered such that a plurality of grid lines and a plurality of local anode lines are simultaneously formed by a single mask. After formation, a SiO_2 coating can be applied over the grid/local anode/cathode complex as set forth in Application No. 07/345,825. The display is also operated in the same fashion as in that application.

FIG. 2 shows an exemplary configuration for a single grid line 20, a single local anode line 28 and their interleaving. As has been recognized previously, the configuration of the grid lines as a tined element, i.e., a element having a plurality of coextensive parallel forks 30 emanating from a common area, here the grid contact pad 24g, improves display brightness as described in U.S. Patent No. 4,742,345. In the embodiment shown in FIG. 2, the local anode 28 is depicted as having a single elongated portion 32 emanating from a contact pad portion 241a. The elongated portion 32 of the local anode 28 extends between the forks 30 of the grid line 20, and, in this sense, interleaves with the grid line 20. It should be noted that the local anode 28 could also be provided with forks like those of the grid line 20, and in that event, the interleaving could be in the form of alternating grid and local anode forks. Indeed, any number of grid forks 30 (elongated portions) and local anode forks or elongated portions 32 could be employed. It is required, however, that they be insulated one from another, and, in order to provide a regular coordinate grid along with the cathode lines 18, should be substantially parallel to each other and perpendicular to the cathode lines 18. It is preferred that the local anode line 28 as shown in FIG. 2 have a width of approximately 30 microns, that a spacing of 12 microns separate the elongated portion 32 of the local anode 28 from the forks 30 of the grid line 20, and that the grid forks 30 be approximately 10 microns wide with an inter-fork spacing of 12 microns. These dimensions provide a local anode 28 which is wider than the grid forks 30 and which allows better pigment hiding than if the local anode were narrower. Overall, the interleaved grid and local anode elements configured according to these dimensions have an open area to closed area ratio of approximately 40%, which is within the range of normal triode EPIDS and a screen produced in accordance with these dimensions has a normal display brightness. Open area ration should be in the range of 30% to 60% for adequate screen brightness.

To form an EPID 10 like that shown in FIG. 1, the parts may assembled in a stack and placed in an oven for baking. The spacer 16, in that case, would be coated on surfaces which contact adjacent elements with a material which would become plastic at baking temperatures. such as, epoxy. Upon baking, the meltable material flows and the elements form a laminate upon cooling. Of course, other methods exist within the scope of the normally skilled artisan for assembling the elements of the EPID 10 shown, such as, e.g., gluing. The lamination of the EPID elements forms an envelope for containing the dielectric fluid/pigment particle suspension.

FIG. 3 shows the electrophoretic display of FIG. 1 utilizing the interleaving configuration shown in FIG. 2 assembled and in cross-section. The anode 26 in the embodiment shown, is a plate-like area of conductor material having a length and width essentially matching that of the cathode/grid/local anode matrix, i.e., coextensive with the matrix, as is taught in the above referenced patents and applications of the present Applicant. Unlike previous teachings, the present invention has the local anode 28 elements deposited upon photoresist layer 22 in the same plane and by the same manufacturing step as the grid elements 20 (the individual forks 30 being shown in cross-section). Since all conductor elements are quite thin, they extend beneath the interstitial spacer 16 without special provision and at least one end thereof provides a terminal exterior to the envelope for connecting display driver circuitry (not shown).

The proportions of the grid and local anode lines as shown in FIGS. 1-3 have been distorted for the purposes of illustration, viz., the elongated portions would be long enough to extend substantially the entire height of the cathode faceplate 14, whereas the width of the individual lines would be small enough to accommodate in the order of 2,200 lines on an 8" X 10" screen. Thus, in real displays the grid and anode lines are very thin and elongated. A workable panel would have a large number of intersections, e.g., 2,200 X 1,700 or a total of 3,740,000 separately addressable intersection points. For ease of illustration, only a few cathode lines 18, grid lines 20, and local anode lines 28 are depicted. More illustrations of electrophoretic displays, their components and electrical circuitry can be seen by referring to U.S. Patents Nos. 4,742,345 and 4,772,820, each being awarded to the inventors herein.

FIGS. 4 and 5, are illustrations of certain features of EPIDS disclosed by the Applicants herein in Application No.07/345,825 and are included for the purpose of providing a comparison to the present invention. Elements having essentially the same form and function as corresponding elements in the present invention are labelled with the same reference numerals. Common elements in the prior EPIDS which have been altered in the present invention are flagged by the suffix "pa". FIG. 4 illustrates the configuration for a tined grid (and local anode) element 20pa previously disclosed in Application No.07/345,825. On comparison to the grid element 20 configuration taught by the present invention, it should be observed that, while the tined configuration is retained, a spacing must be provided centrally to ac-

commodate the interleaved anode line.

FIG. 5 illustrates the stacking of the local anode elements 28pa upon the grid elements 20pa previously used by the applicants in EPIDS having a remote and a local anode. It should be appreciated that this stacking configuration is done in several steps and that the local anode 28pa must be closely aligned with the grid elements 20pa for effective operation. The present invention has neither of these requirements. Another difference between the present invention and that shown in FIG. 5 is that the local anode 28 of the present invention alters the distribution of pigment particles in the plane of the grid and the local anode. In contrast, in the device shown in FIG. 5, the local anode effects pigment concentration at the grid by drawing it into a plane removed from the grid.

It should be understood that the embodiments described herein are merely exemplary and that a person skilled in the art may make many variations and modifications without departing from the scope of the invention as defined in the appended claims.

Claims

1. An electrophoretic display having a cathode array comprising a plurality of conductive parallel lines (18) arranged in a given direction, with a grid array insulated from said cathode array and comprising a plurality of conductive parallel lines (20) each perpendicular to said cathode lines to form an X-Y addressing matrix with a conventional anode electrode (26) separated from said X-Y matrix with the space between said anode electrode and said X-Y matrix accommodating an electrophoretic dispersion including pigment particles suspended in a fluid, and

   an additional anode electrode (28) comprising a plurality of parallel lines each associated with and insulated from said grid lines, and operative to control the path of said pigment particles to and from said X-Y matrix and to allow excess pigment to remain at said conventional anode electrode, characterized in that said additional anode electrode is disposed within a plane shared by said grid array.

2. The display of Claim 1, wherein said additional anode lines are distributed in said plane and between said grid lines in a predetermined repeating pattern.

3. The display of Claim 2, wherein each of said grid lines is associated with a corresponding one of said additional anode lines.

4. The display of Claim 3, wherein each of said grid lines and said additional anode lines have an end (24g, 24la) for connecting to display driver circuitry and a free end and wherein said connecting ends of each associated grid line and additional anode line are disposed distal to each other.

5. The display of Claim 4, wherein each grid line subdivides distal to said connecting end into at least two tines (30) and said free end of each associated additional anode line inserts between said tines.

6. The display of Claim 5, wherein said at least two tines are four in number and said associated additional anode line is disposed approximately centrally between two sets of two tines of an associated said subdivided grid line.

7. The display of Claim 6, wherein said local anode line is wider than said tines of said grid lines such that said local anode line obscures more pigment particles than said tines.

8. The display of Claim 7, wherein said X-Y matrix and said additional anode matrix together have a combined open area ratio of approximately from 30 to 60%.

9. The display of Claim 1, wherein said additional anode lines and said grid lines are each formed from the same material.

10. An electrophoretic display comprising:

    (a) a fluid-tight envelope having a portion thereof which is at least partially transparent;
    (b) an electrophoretic fluid contained within said envelope, said fluid having pigmented particles suspended therein;
    (c) a plurality of elongated substantially parallel horizontal conductor elements (18) disposed within a first plane and at least partially contained within said envelope;
    (d) a first plurality of elongated substantially parallel vertical conductor elements (20) at least partially contained within said envelope electrically insulated from said horizontal elements and disposed within a second plane, said first and said second planes being substantially parallel and in proximity to each other, said plurality of horizontal elements and said plurality of vertical elements being perpendicular to each other thereby forming a matrix with a plurality of intersections when viewed along a line perpendicular to said first and said second planes;
    (e) a second plurality of elongated substantially parallel vertical conductor elements (28) at least partially contained within said envelope electrically insulated from said horizontal elements and said first plurality of vertical elements; and

(f) a substantially planar conductor member (26) disposed within a third plane proximate and substantially parallel to said second plane and at least partially contained within said envelope, each of said first and second pluralities of vertical elements and said horizontal elements being selectively electrically chargeable to induce movement of said particles within said fluid, said particles being visible through said transparent portion of said envelope,

characterized in that said second plurality of vertical elements is disposed within said second plane.

11. The display of Claim 10, wherein said second plurality of vertical elements is distributed in said second plane interleaved between said first plurality of elements in a repeating pattern and wherein each element of said first plurality is associated with a corresponding element of said second plurality.

12. The display of Claim 11, wherein said first and second pluralities of elements are each supported upon a layer of photoresist (22).

13. The display of Claim 12, wherein each of said first and second pluralities of elements have an end (24g, 24la) for connecting to display driver circuitry and a free end, said connecting ends of each of said first plurality of elements being disposed distal to said connecting end of a corresponding element of said second plurality of elements, wherein each element of said first plurality of elements subdivides distal to said connecting end into at least two tines (30) and said free end of a corresponding element of said second plurality of elements inserts between said tines.

14. The display of Claim 13, wherein said first and said second plurality of elements are each formed from chromium.

15. The display of Claim 13, wherein said first and said second plurality of elements are each formed from aluminum.

16. The display of Claim 13, wherein said display is a tetrode-type display, said plurality of horizontal elements (18) being the cathode, said first plurality of vertical elements (20) being the grid, said second plurality of vertical elements (28) being the local anode and said planar member (26) being the remote anode.

17. A method for fabricating a cathode/grid/local anode matrix on the cathode faceplate of a dual anode electrophoretic display comprises performing, in substantially the order shown, the steps of:

(a) forming a plurality of cathode lines (18) on said cathode faceplate (14);
(b) depositing a first layer of photoresist (22) over said cathode lines;
(c) coating said first layer of photoresist with a conductor material;
(d) coating said conductor material with a second layer of photoresist;
(e) masking said second layer of photoresist with a mask corresponding to the shape of a plurality of grid lines (20) interleaved with a plurality of local anode lines (28);
(f) exposing said second layer of photoresist through said mask;
(g) developing said second layer of photoresist;
(h) acid etching said conductor material coating where not covered by said second layer of photoresist remaining after developing; and
(i) plasma etching said first and said second layers of photoresist where not covered by said conductor material remaining after said step of acid etching.

18. The method of Claim 17, further including the step of applying a SiO_2 coating over said cathode/grid/local anode matrix after said step of plasma etching.

19. The method of Claim 18, wherein said step of coating with a conductor material includes sputtering a layer of chrome upon said first layer of photoresist.

20. The method of Claim 18, wherein said step of coating with a conductor material includes sputtering a layer of aluminum upon said first layer of photoresist.

Patentansprüche

1. Elektrophoretisches Display mit einer aus einer Vielheit von in einer gegebenen Richtung angeordneten leitfähigen parallelen Zeilen (18) bestehenden Kathodenmatrix, einer gegen besagte Kathodenmatrix isolierten und aus einer Vielheit von zur Bildung einer X-Y-Adressiermatrix jeweils senkrecht zu besagten Kathodenzeilen verlaufenden leitfähigen parallelen Zeilen (20) bestehenden Gittermatrix, mit einer von besagter X-Y-Matrix getrennten herkömmlichen Anodenelektrode (26), wobei der Raum zwischen besagter Anodenelektrode und besagter X-Y-Matrix eine elektrophoretische Dispersion mit einem in einem Fluid schwebenden Pigmentpartikeln enthält, und mit einer zusätzlichen aus einer Vielheit von jeweils mit gesagten Gitterzeilen verbundenen und gegen dieselben isolierten parallelen Zeilen bestehenden Anodenelektrode (28), die die Bewegung besagter Pigmentpartikel zu besagter X-Y-Matrix und von dieser

weg steuert und überschüssiges Pigment bei besagter herkömmlicher Anodenelektrode läßt, dadurch gekennzeichnet, daß besagte zusätzliche Anodenelektrode in einer gemeinsamen Ebene mit besagter Gittermatrix liegt.

2. Display gemäß Anspruch 1, wobei besagte zusätzliche Anodenzeilen in einem vorgegebenen Wiederholmuster in besagter Ebene und zwischen besagten Gitterzeilen verteilt sind.

3. Display gemäß Anspruch 2, wobei eine jede der besagten Gitterzeilen mit einer entsprechenden zusätzlichen Anodenzeile verbunden ist.

4. Display gemäß Anspruch 3, wobei eine jede der besagten Gitterzeilen und der besagten zusätzlichen Anodenzeilen ein Ende (24g, 24la) zum Anschluß an Displaytreiberschaltungen und ein freies Ende hat, und wobei besagte Anschlußenden einer jeden zugehörigen Gitterzeile und zusätzlichen Anodenzeile im Verhältnis zueinander distal angeordnet sind.

5. Display gemäß Anspruch 4, wobei eine jede Gitterzeile distal zu besagtem Anschlußende in mindestens zwei Zacken (30) zerfällt und besagtes freies Ende einer jeden zugehörigen zusätzlichen Anodenzeile zwischen besagte Zacken eingeführt wird.

6. Display gemäß Anspruch 5, wobei von besagten mindestens zwei Zacken vier Stück vorgesehen sind und besagte zusätzliche Anodenzeile in der Mitte zwischen zwei Sätzen von zwei Zacken einer zugehörigen besagten unterteilten Gitterzeile liegt.

7. Display gemäß Anspruch 6, wobei besagte Lokalanodenzeile breiter ist als besagte Zacken der besagten Gitterzeilen, so daß besagte Lokalanodenzeile mehr Pigmentpartikel verdunkelt als besagte Zacken.

8. Display gemäß Anspruch 7, wobei besagte X-Y-Matrix und besagte zusätzliche Anodenmatrix zusammen ein kombiniertes Offenflächenverhältnis von ca. 30% bis 60% haben.

9. Display gemäß Anspruch 1, wobei besagte zusätzliche Anodenzeilen und besagte Gitterzeilen aus dem selben Material gebildet werden.

10. Elektrophoretisches Display bestehend aus:

(a) einer flüssigkeitsdichten Hülle mit einem Abschnitt, der mindestens teilweise transparent ist;
(b) einem in besagter Hülle enthaltenen elektrophoretischen Fluid, in welchem pigmentierte Partikel schweben;
(c) einer Vielheit von länglichen, im wesentlichen parallelen waagerechten Leiterelementen (18), die in einer ersten Ebene abgelagert und mindestens teilweise in besagter Hülle enthalten sind;
(d) einer ersten Vielheit von länglichen, im wesentlichen parallelen senkrechten Leiterelementen (20), die mindestens teilweise in besagter Hülle enthalten, gegen besagte waagerechte Elemente isoliert und in einer zweiten Ebene abgelagert sind, wobei besagte erste und zweite Ebenen im wesentlichen parallel und nahe beieinander liegen und besagte Vielheit vom waagerechten Elementen und besagte Vielheit von senkrechten Elementen senkrecht zueinander liegen und auf diese Weise bei Betrachtung gemäß einer senkrecht zu besagten ersten und besagten zweiten Ebenen liegenden Linie eine Matrix mit einer Vielheit von Schnittpunkten bilden;
(e) einer zweiten Vielheit von länglichen, im wesentlichen parallelen senkrechten Leiterelementen (28), die mindestens teilweise in besagter Hülle enthalten und gegen besagte waagerechte Elemente und besagte erste Vielheit von senkrechten Elementen isoliert sind; und
(f) einem im wesentlichen planaren Leiterelement (26), das in einer dritten neben der und im wesentlichen parallel zur besagten zweiten Ebene liegenden Ebene abgelagert und mindestens teilweise in besagter Hülle enthalten ist, wobei besagte erste und zweite Vielheit von senkrechten Elementen und besagte waagerechte Elemente selektiv elektrisch aufgeladen werden können, um eine Bewegung besagter Partikel in besagtem Fluid zu veranlassen, wobei besagte Partikel mindestens teilweise durch den transparenten Abschnitt besagter Hülle sichtbar sind, dadurch gekennzeichnet, daß zweite besagte Vielheit von senkrechten Elementen in besagter zweiter Ebene abgelagert ist.

11. Display gemäß Anspruch 10, wobei besagte zweite Vielheit von senkrechten Elementen in einem Wiederholmuster in besagter zweiter Ebene verteilt und mit besagter erster Vielheit von Elementen verschachtelt ist, und wobei ein jedes Element der besagten ersten Vielheit mit einem entsprechenden Element der besagten zweiten Vielheit verbunden ist.

12. Display gemäß Anspruch 11, wobei besagte erste und zweite Vielheiten von Elementen jeweils von einer Photoresistschicht (22) getragen werden.

13. Display gemäß Anspruch 12, wobei eine jeder der besagten ersten und zweiten Vielheiten von Elementen ein Ende (24g, 24la) zum Anschluß an eine Displaytreiberschaltung und ein freies Ende hat und besagte Anschlußenden einer jeden ersten Vielheit von Elementen distal zum besagten Anschlußende eines entsprechenden Elements der besagten zweiten Vielheit von Elementen liegen, wobei ein jedes Element der besagten ersten Vielheit distal zu besagtem Anschlußende in mindestens zwei Zacken (30) aufgeteilt ist und besagtes freies Ende eines entsprechenden Elements der besagten zweiten Vielheit von Elementen zwischen besagte Zacken eingeführt wird.

14. Display gemäß Anspruch 13, wobei besagte erste und zweite Vielheit von Elementen jeweils aus Chrom bestehen.

15. Display gemäß Anspruch 13, wobei besagte erste und zweite Vielheit von Elementen jeweils aus Aluminium bestehen.

16. Display gemäß Anspruch 13, wobei besagtes Display ein Tetroden-Display ist, in dem besagte Vielheit von waagerechten Elementen (18) die Kathode, besagte erste Vielheit von senkrechten Elementen (20) das Gitter, besagte zweite Vielheit von senkrechten Elementen (28) die Lokalanode und besagtes planares Element (26) die Fernanode bilden.

17. Verfahren zur Herstellung einer Kathoden-/Gitter/Lokalanodenmatrix auf einem Kathodenschirmträger eines elektrophoretischen Doppelanoden-Displays, im wesentlichen bestehend aus den folgenden in der angegebenen Reihenfolge auszuführenden Schritten:

(a) Bildung einer Vielheit von Kathodenzeilen (18) auf besagtem Anodenschirmträger (14);
(b) Ablagerung einer ersten Photoresistschicht (22) über besagten Kathodenzeilem;
(c) Beschichtung besagter erster Photoresistschicht mit einem Leitermaterial;
(d) Beschichtung besagten Leitermaterials mit einer zweiten Photoresistschicht;
(e) Abdecken besagter zweiter Photoresistschicht mit einer Maske, die der Form einer Vielheit von Gitterzeilen (20) entspricht, die mit einer Vielheit von Lokalanodenzeilen (28) verschachtelt sind;
(f) Belichtung besagter zweiter Photoresistschicht durch besagte Maske;
(g) Entwickeln besagter zweiter Photoresistschicht;
(h) Säureätzung besagter Leitermaterialbeschichtung an den nicht von besagter zweiter nach dem Entwickeln verbleibender Photoresistschicht bedeckten Stellen; und
(i) Plasmaätzung besagter erster und zweiter Photoresistschichten an den nicht von besagtem nach dem Schritt der Säureätzung verbleibendem Leitermaterial bedeckten Stellen.

18. Verfahren gemäß Anspruch 17, mit dem weiteren Schritt des Auftragens einer SiO_2-Schicht über besagter Kathoden-/Gitter-/Lokalanodenmatrix nach besagtem Schritt der Plasmaätzung.

19. Verfahren gemäß Anspruch 18, wobei bei besagtem Schritt der Beschichtung mit Leitermaterial eine Chromschicht auf die erste Photoresistschicht aufgedampft wird.

20. Verfahren gemäß Anspruch 18, wobei bei besagtem Schritt der Beschichtung mit Leitermaterial eine Aluminiumschicht auf die erste Photoresistschicht aufgedampft wird.

Revendications

1. Un afficheur électrophorétique ayant un arrangement de cathode comprenant une pluralité de lignes parallèles conductrices (18) arrangée dans une direction donnée, avec un arrangement de grille isolé dudit arrangement de cathode et comprenant une pluralité de lignes parallèles conductrices (20) chacune perpendiculaire auxdites lignes de cathode pour former une matrice d'adressage X-Y, l'électrode d'anode traditionnelle (26) étant séparée de ladite matrice X-Y avec l'espace entre ladite électrode d'anode et ladite matrice X-Y contenant une dispersion électrophorétique comprenant des particules de pigment suspendues dans un fluide, et
une électrode d'anode supplémentaire (28) comprenant une pluralité de lignes parallèles, chacune associée à et isolée desdites lignes de grille et active pour contrôler le trajet desdites particules de pigment vers et en provenance de ladite matrice X-Y et pour permettre au pigment excédentaire de rester sur l'électrode d'anode traditionnelle, caractérisée en ce que ladite électrode d'anode supplémentaire est disposée dans un plan partagé par ledit arrangement de grille.

2. L'afficheur suivant la Revendication 1, où lesdites lignes de l'anode supplémentaire sont distribuées dans ledit plan et entre lesdites lignes de grille selon un modèle répété prédéterminé.

3. L'afficheur suivant la Revendication 2, où chacune desdites lignes de grille est associée à une ligne correspondante desdites lignes de l'anode supplémentaire.

4. L'afficheur suivant la Revendication 3, où chacune desdites lignes de grille et desdites lignes de l'anode supplémentaire a une extrémité (24g, 24la) pour connexion sur le circuit de commande de l'afficheur et une extrémité libre et où lesdites extrémités de connexion de chaque ligne de grille et chaque ligne de l'anode supplémentaire associées sont disposées de manière distale les unes par rapport aux autres.

5. L'afficheur suivant la Revendication 4, où chaque ligne de grille se subdivise de manière distale par rapport à ladite extrémité de connexion dans au moins deux dents (30) et ladite extrémité libre de chaque ligne d'anode supplémentaire associée s'insère entre lesdites dents.

6. L'afficheur suivant la Revendication 5, où lesdites au moins deux dents sont au nombre de quatre et ladite ligne d'anode supplémentaire associée est disposée approximativement centralement entre les deux ensembles de deux dents d'une dite ligne de grille subdivisée associée.

7. L'afficheur suivant le Revendication 6, où ladite ligne d'anode locale est plus large que lesdites dents desdites lignes de grille de sorte que ladite ligne d'anode locale cache plus de particules de pigment que lesdites dents.

8. L'afficheur suivant le Revendication 7, où ladite matrice X-Y et ladite matrice d'anode supplémentaire ont ensemble un rapport de zone ouverte combinée d'environ 30 à 60 %.

9. L'afficheur suivant la Revendication 1, où lesdites lignes d'anode supplémentaire et lesdites lignes de grille sont chacune formées à partir du même matériau.

10. Un afficheur élecnrophorétique comprenant:

(a) une enveloppe étanche au fluide dont une partie est au moins partiellement transparente;
(b) un fluide électrophorétique contenu dans ladite enveloppe, ledit fluide contenant des particules de pigment qui y sont suspendues;
(c) une pluralité d'éléments conducteurs allongés horizontaux substantiellement parallèles (18) disposés dans un premier plan et au moins partiellement contenus dans ladite enveloppe;
(d) une première pluralité d'éléments conducteurs allongés verticaux substantiellement parallèles (20) au moins partiellement contenus dans ladite enveloppe électriquement isolée desdits éléments horizontaux et disposés dans un second plan, ledit premier et ledit second plans étant substantiellement parallèles et à proximité l'un de l'autre, ladite pluralité d'éléments horizontaux et ladite pluralité d'éléments verticaux étant perpendiculaires l'une par rapport à l'autre, formant ainsi une matrice avec une pluralité d'intersections vue le long d'une ligne perpendiculaire auxdits premier et second plans;
(e) une seconde pluralité d'éléments conducteurs allongés verticaux substantiellement parallèles (26) au moins partiellement contenus dans ladite enveloppe électriquement isolée desdits éléments horizontaux et ladite première pluralité d'éléments verticaux; et
(f) un membre conducteur substantiellement planar (26) disposé dans un troisième plan adjacent et substantiellement parallèle audit second plan et au moins partiellement contenu dans ladite enveloppe, chacun desdites première et seconde pluralités d'éléments verticaux et desdits éléments horizontaux étant sélectivement chargés électriquement pour induire le mouvement desdites particules dans ledit fluide, lesdites particules étant visibles au travers de ladite partie transparente de ladite enveloppe, caractérisé en ce que ladite seconde pluralité d'éléments verticaux est disposée dans ledit second plan.

11. L'afficheur suivant la Revendication 10, où ladite seconde pluralité d'éléments verticaux est distribuée dans ledit second plan imbriqué entre ladite première pluralité d'éléments selon un modèle répété et où chaque élément de ladite première pluralité est associé à un élément correspondant de ladite seconde pluralité.

12. L'afficheur suivant la Revendication 11, où lesdites première et seconde pluralités d'éléments sont chacune supportées sur une couche de photorésist (22).

13. L'afficheur suivant la Revendication 12, où chacune desdites première et seconde pluralités d'éléments a une extrémité (24g, 24la) pour connexion sur le circuit de commande de l'afficheur et une extrémité libre, lesdites extrémités de connexion de chacune de ladite première pluralité d'éléments étant disposées de manière distale par rapport à la dite extrémité de connexion d'un élément correspondant de ladite seconde pluralité d'éléments, où chaque élément de ladite première pluralité d'éléments se subdivise de manière distale par rapport à ladite extrémité de connexion en au moins deux dents (30) et ladite extrémité libre d'un élément correspondant de ladite seconde pluralité d'éléments s'insère entre lesdites dents.

14. L'afficheur suivant la Revendication 13, où lesdites

première et seconde pluralités d'éléments sont chacune formées de chrome.

15. L'afficheur suivant la Revendication 13, où lesdites première et seconde pluralités d'éléments sont chacune formées d'aluminium.

16. L'afficheur suivant la Revendication 13, où ledit afficheur est un afficheur du type tétrode, ladite pluralité d'éléments horizontaux (18) étant la cathode, ladite première pluralité d'éléments verticaux (20) étant la grille, ladite seconde pluralité d'éléments verticaux (28) étant l'anode locale et ledit membre planar (26) étant l'anode à distance.

17. Un procédé de fabrication d'une matrice cathode/grille/anode locale sur la plaque de cathode d'un afficheur électrophorétique à anode double comprend l'exécution, dans substantiellement l'ordre indiqué, des étapes de:

(a) formation d'une pluralité de lignes de cathode (18) sur ladite plaque de cathode (14);
(b) dépôt d'une première couche de photorésist (22) sur lesdites lignes de cathodes;
(c) revêtement de ladite première couche de photorésist avec un matériau conducteur;
(d) revêtement dudit matériau conducteur par une deuxième couche de photorésist;
(e) masquage de ladite deuxième couche de photorésist avec un masque correspondant à la forme d'une pluralité de lignes de grille (20) imbriquée avec une pluralité de lignes de l'anode locale (28);
(f) exposition de ladite seconde couche de photorésist au travers dudit masque;
(g) développement de ladite seconde couche de photorésist;
(h) attaque à l'acide dudit revêtement de matériau conducteur non couvert par ladite seconde couche de photorésist qui reste après le développement; et
(i) attaque au plasma desdites première et seconde couches de photorésist non couvertes par ledit matériau conducteur qui reste après ladite étape d'attaque à l'acide.

18. Le procédé suivant la Revendication 17, comprenant en outre l'étape d'application d'un revêtement de SiO_2 sur ladite matrice cathode/grille/anode locale après ladite étape d'attaque au plasma.

19. Le procédé suivant le Revendication 18, où ladite étape de revêtement avec un matériau conducteur inclut la pulvérisation d'une couche de chrome sur ladite première couche de photorésist.

20. Le procédé suivant la Revendication 18, où ladite étape de revêtement avec un matériau conducteur inclut la pulvérisation d'une couche d'aluminium sur ladite première couche de photorésist.

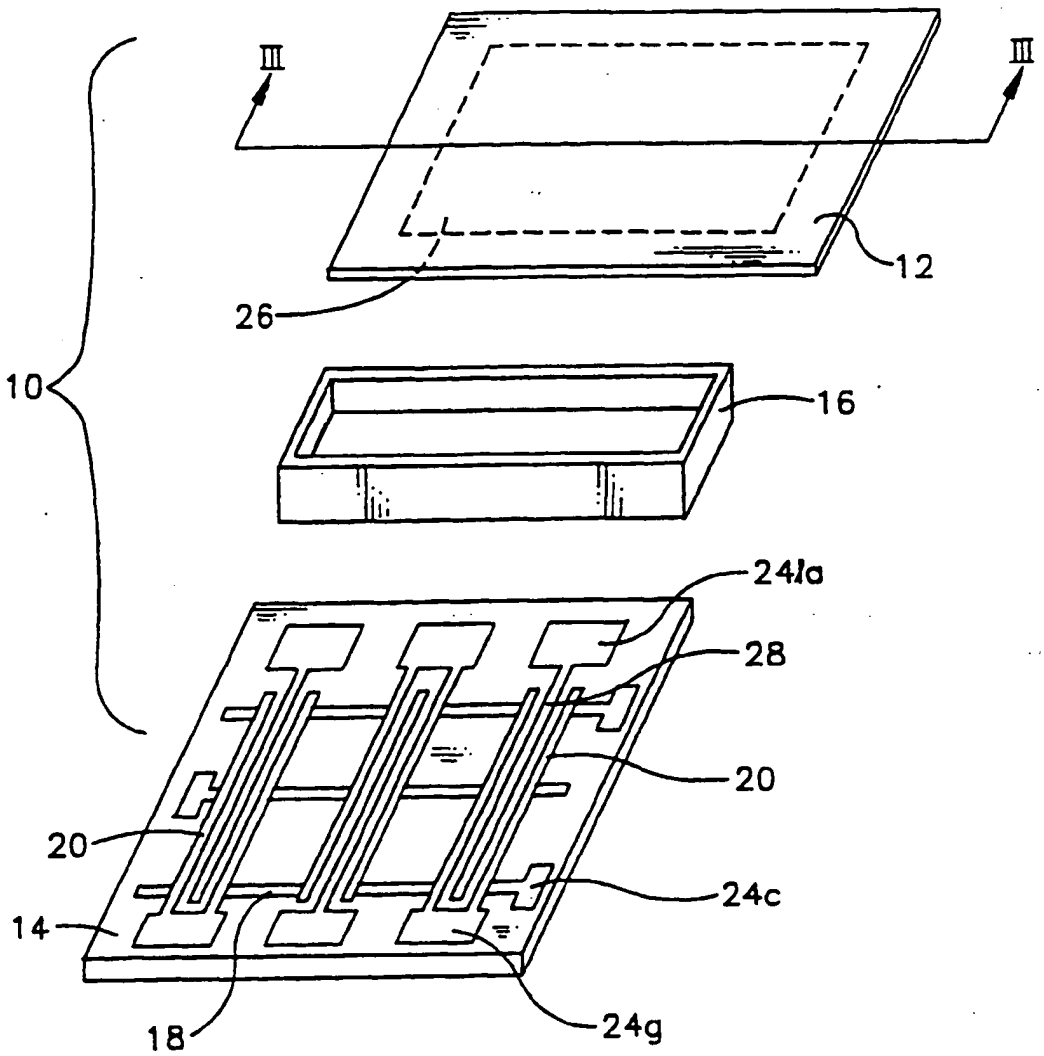

FIG. 1

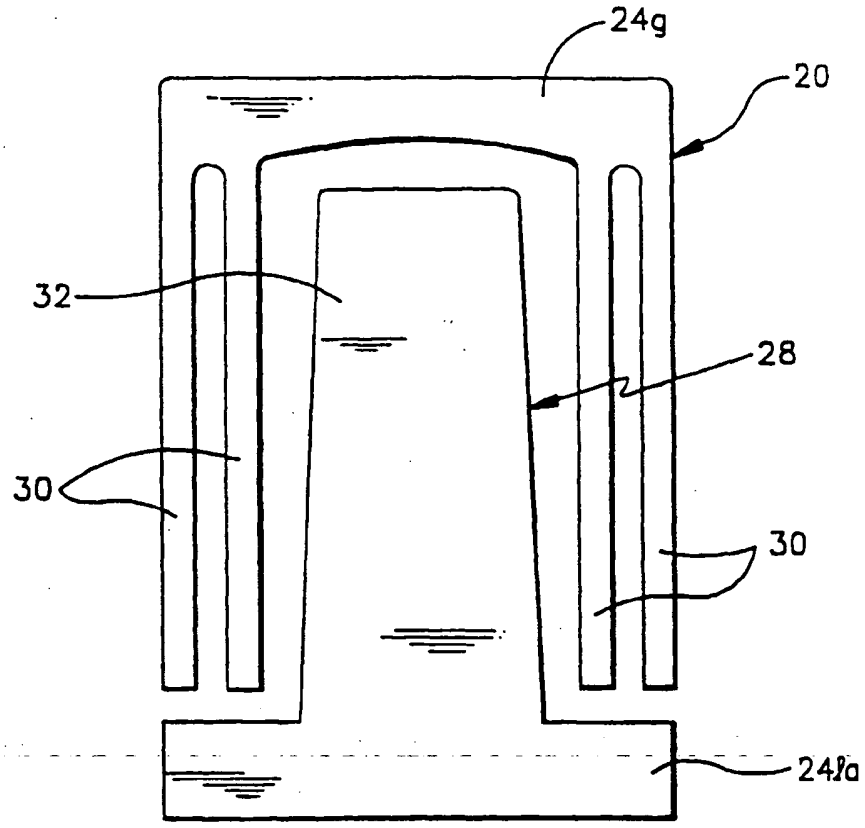

FIG. 2

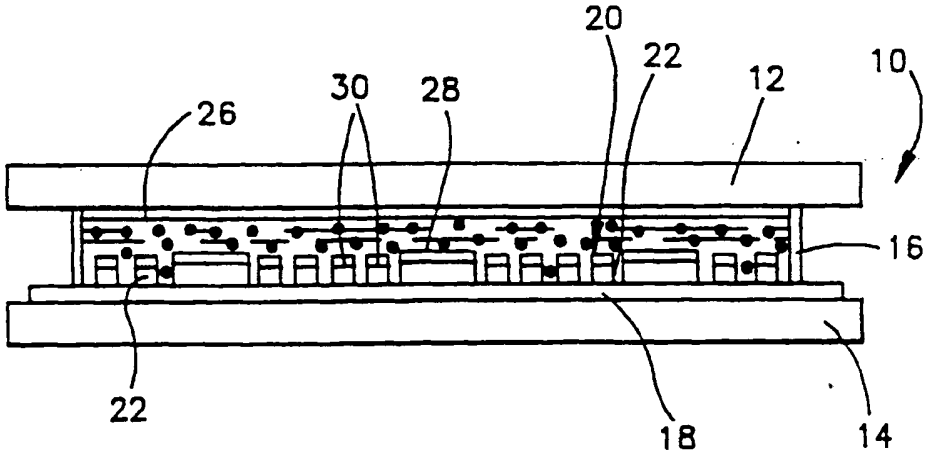

FIG. 3

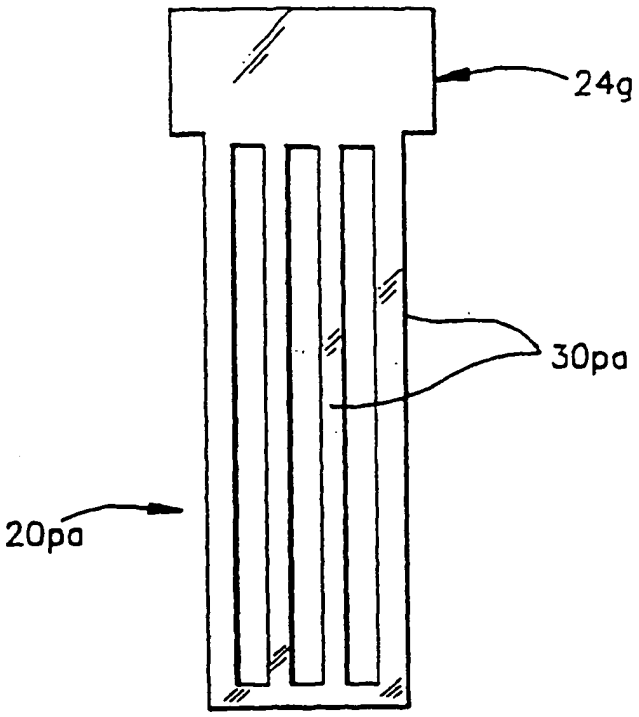

FIG. 4

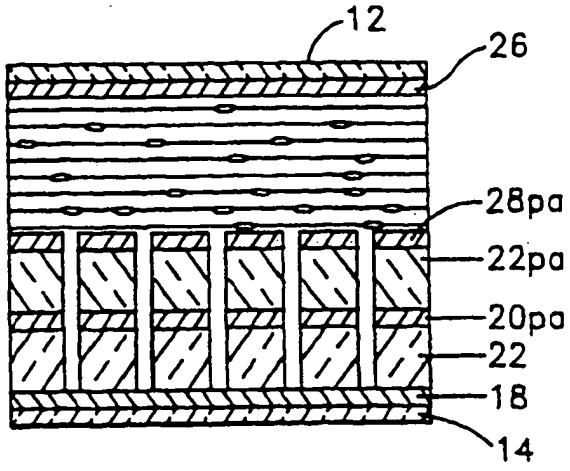

FIG. 5

THIS PAGE IS BLANK